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**HOSPITALIZATIONS FOR ACCIDENTS AND  
INJURIES IN THE U.S. NAVY  
I. DUTY STATION ASSIGNMENT AND DUTY STATUS**

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HOSPITALIZATIONS FOR ACCIDENTS AND INJURIES IN THE U.S. NAVY

I. DUTY STATION ASSIGNMENT AND DUTY STATUS

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## SUMMARY

### Problem

The ICDA category of Accidents, Poisonings and Violence (APV) was shown to be the leading cause of hospitalization among Navy and Marine Corps Personnel during the period 1975-1979. In order to provide more specific and effective accident prevention programs, it is necessary to obtain a better understanding of environmental and occupational factors and how they may contribute to accidents in the U.S. Navy.

### Objective

The objective of this study was to provide more detailed analyses of accidental injury-related hospitalizations as a function of work environment characteristics such as duty station assignment and duty status and to determine if these factors affected one's risk of injury and subsequent hospitalization.

### Approach

Participants included all male enlisted personnel who had an accident during the three-year period from 1977-1979 that resulted in hospitalization, a Medical Board, a Physical Evaluation Board or death. Data were obtained from the medical history files maintained at the Naval Health Research Center. The following classifications were used to further describe the circumstances of individual injuries: (1) duty station, and (2) duty status (on-duty, off-duty, or duty status unspecified).

### Results

Compared to the standard Navy rate, UDT/Seal, Destroyer, and conventionally powered Aircraft Carrier and Cruiser personnel had significantly higher injury hospitalization rates, whereas nuclear submariners and shore-based personnel had rates significantly lower. When looking at the effects of duty status on injury-related hospitalization, personnel assigned to Destroyers, Replenishment ships and conventionally powered Carriers had higher on-duty hospitalization rates, while nuclear submariners and shore-based personnel had lower on-duty rates compared to Navywide norms. A positive and significant correlation was observed between on- and off-duty hospitalization rates suggesting that common personal attributes such as risk-taking behavior are manifested both on and off the job.

### Conclusions/Recommendations

This study has shown that duty status and type of duty station influence the risk of hospitalization due to injury. Further analyses are needed to determine if there are specific factors that may help explain these differences. Such detailed investigations will help identify high-risk assignments where preventive and corrective efforts should be directed.



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## Hospitalizations for Accidents and Injuries in the U.S. Navy

### I. Duty Station Assignment and Duty Status

#### INTRODUCTION

The category of Accidents, Poisonings, and Violence (APV) was shown to be the leading cause of hospitalization among Navy and Marine Corps personnel during the period 1975-1979 [Medical Statistics, U.S. Navy, 1984]. Furthermore, the APV category accounted for nearly 25% of all days lost because of hospitalizations for Navy personnel or almost one-half million noneffective days. The rising cost of providing medical treatment to injured personnel, coupled with the associated loss in manpower, provides a strong incentive to reduce accidents.

Recent Naval Health Research Center studies of accidents and injuries focused on variables measuring individual characteristics, occupation, pay grade, and duty status [Ferguson, McNally, and Booth, 1981a; Ferguson, McNally, Booth, 1981b; Ferguson, McNally, Booth, 1984; Helmkamp and Colcord, 1984; McNally and Ferguson, 1984]. It was hypothesized that duty station assignment at the time of injury also might prove to be an important variable; however, this kind of data was not available at the time of the earlier studies. Such information recently has become available so that the previous studies can be rounded out with an analysis of the work setting in relation to the risk of an accident or injury. Specifically, the question of whether type of duty station (ship type, shore vs sea duty, etc.) affects injury rates can now be answered, and further refinements in the analysis of occupational factors that impact on accident risks can be addressed.

This study determined accidental injury hospitalization rates for major operational, administrative, tactical, and support duty stations in the Navy. These rates were compared to total Navy rates to identify high risk assignments.

#### METHODS

The first step in the analysis was to determine where an individual was stationed when an injury occurred. Reliable data on duty station assignment were not available until 1973; therefore, a recent time frame was selected for the analysis.

Medical data were obtained from computer files at the Naval Medical Data Services Center, Bethesda, Maryland. These records were edited and incorporated into medical history files for all active duty naval personnel maintained at the Naval Health Research Center, San Diego. Participants in the study included all male enlisted personnel who had an accident during the three-year period from 1977-1979 that resulted in hospitalization, a Medical Board, a Physical Evaluation Board, or death. The term "hospitalization" will be used throughout this report to collectively describe these outcome events. Hospitalizations were coded in accordance with the Accidents, Poisonings, and Violence category (Codes 800-999) of the eighth revision of the International Classification of Diseases, Adapted for Use in the United States. Injuries that were self-inflicted, combat related, or the result of an assault were not included. Additional classifications were used to further describe the circumstances of individual injuries: 1) type of duty station to which an individual was assigned at the time of injury, and 2) duty status when the injury occurred--on-duty, off-duty, or duty status unspecified.

Population data, for all male enlisted Navy personnel and for major duty stations, were compiled from data files obtained from the Manpower and Personnel Management Information System and now maintained at the Naval Health Research Center. For each type of duty station it was necessary to obtain an estimate of the annual population which takes into account fluctuations that occur from one part of a year to another. The estimate of population for a calendar year was based on the average strength for five quarterly reporting periods (December of the previous year, March, June, September, and December). This was considered to be a more accurate estimate than one based on four quarters. A listing of the various tactical and operational duty stations and their average annual population at risk are presented later in Table 1.

Injury-related hospitalization rates for each duty station were computed by taking the three-year annual average number of injuries and dividing it by the average population for that activity. These rates were then compared to the total Navy rate to see if any statistically significant differences were present. The following formula was used to calculate these rates [Lilienfeld and Lilienfeld, 1980; Monson, 1980]:

$$\text{Injury Hospitalization Rate} = \frac{\text{Average annual number of hospitalizations for accidental injury}}{\text{Average annual population for specific duty station}} \times 10,000$$

These rates were age-adjusted according to methods outlined by Lilienfeld [1980]. This adjustment will help reduce potential bias and allow more valid comparisons between duty stations.

Relative risks (RR = a/b) were computed using the total Navy rate as the standard rate (denominator b), compared to a specific duty station's rate (numerator a). Thus, a relative risk of one (1.0) meant that the accidental injury hospitalization rate for a specific type of duty station was the same as the total Navy rate, and a relative risk of less than or greater than one (1.0) meant that the hospitalization rate for the specific group was less than or greater than the total Navy rate, respectively.

Statistical significance was assessed by utilizing the following formula designed for dependent rates [Dever, 1984]:

$$\text{Mu} = (r-s) \sqrt{n/(s-s^2)}$$

where: r = the rate to be compared

s = the standard rate (total Navy)

n = population of specific duty station

If Mu exceeded 1.96, it was concluded that the rate differed significantly, at the 95% confidence level, from the standard rate to which it was compared. If Mu exceeded 2.58, it was significantly different at the 99% level. Percentage differences in hospitalization rates between duty station types were also calculated, using the following formula:

$$\frac{\text{Specific rate A} - \text{Specific rate B}}{\text{Specific rate A}} \times 100 = \text{percent difference between rate A and rate B}$$

For example, Carriers had an average population of 26,217 enlisted men and an injury hospitalization rate of 206 per 10,000, while the total Navy's injury hospitalization rate was 168 per 10,000, giving the ratio of Carriers to total Navy as 1.23 with a significance level of:

$$\text{Mu} = (.0206 - .0168) \sqrt{26,217 / (.0168 - .0168^2)} = 4.79 \text{ (p < .01)}$$

and a rate percentage difference of:

$$\frac{206 - 168}{168} \times 100 = 18.4\%$$

From the above, one would conclude that the accidental injury hospitalization rate for Carrier personnel was significantly greater than the rate for the total Navy, with Carrier personnel having a rate more than 18% greater than Navywide.

Finally, a rank-order correlation was used to determine if a relationship exists between on- and off-duty injury hospitalizations [Daniel, 1983].

#### RESULTS

##### Duty Station Assignment

Table 1 presents age-adjusted accidental injury hospitalization rates and relative risks for each type of duty station for the three-year study period.

Table 1. Average Population at Risk, Accidental Injury Hospitalization Rates, and Relative Risks by Duty Station Assignment for CY 1977-1979

Duty Station Assignment	Population at Risk	Rate <sup>f</sup>	Relative Risk	Sign. Mu
Total Navy <sup>a</sup>	437,719	168	1.00	--
UDT/Seal	803	276	1.64 <sup>d</sup>	p<.05
Carrier	26,217	206	1.23 <sup>d</sup>	p<.01
Cruiser	9,414	206	1.23 <sup>d</sup>	p<.01
Amphibious <sup>b</sup>	23,873	172	1.02	N.S.
Rescue/Salvage	6,422	193	1.15	N.S.
Nuclear Carrier	8,242	181	1.08	N.S.
Destroyer	42,504	183	1.09 <sup>d</sup>	p<.05
Submarine	806	182	1.08	N.S.
Repair	24,578	159	0.95	N.S.
Replenishment	14,118	161	0.96	N.S.
Patrol/Mine	1,295	167	0.99	N.S.
Attack/Fighter Squadron	19,774	165	0.98	N.S.
Patrol Squadron	27,345	160	0.95	N.S.
Helicopter Squadron	6,248	158	0.94	N.S.
Construction Battalion	6,530	154	0.92	N.S.
Nuclear Cruiser	4,320	137	0.82	N.S.
Fleet Marine Force <sup>c</sup>	3,122	134	0.80	N.S.
Nuclear Submarine	18,894	123	0.73 <sup>e</sup>	p<.01
All Other (Shore)	193,214	162	0.96 <sup>e</sup>	p<.01

<sup>a</sup>All male enlisted personnel

<sup>b</sup>Includes only ship's company personnel

<sup>c</sup>Includes only personnel assigned to actual landing forces

<sup>d</sup>Significantly higher than Navy norm

<sup>e</sup>Significantly lower than Navy norm

<sup>f</sup>Rates are per 10,000

Personnel serving aboard four types of sea-based duty stations had injury hospitalization rates that were significantly higher than the Navywide rates. Of these, UDT/Seal had the greatest rate differential (39.1% higher) compared to the Navy norm. Although the rate for UDT/Seal was statistically significant, it should be interpreted cautiously because of the relatively small population at risk (n = 803) compared to other duty stations and the total Navy.

Conventionally powered Carrier and Cruiser personnel both had rates that were 18.5% higher than the Navy norm. Destroyer (including Frigate) personnel, which collectively represent the operational group with the largest average population at risk (n = 42,504), also had a hospitalization rate that was significantly higher than the Navy norm.

Nuclear submariners experienced a hospitalization rate that was 36.6% lower than the rate observed Navywide. The "All Other" duty station category, which was composed almost entirely of shore-based administrative, support, and service-oriented personnel (e.g., hospitals, training centers, supply centers, etc.) also had a rate that was significantly lower than the Navy norm.

Table 2. Accidental Injury Hospitalization Rates and Relative Risks by  
Duty Status and Duty Station Assignment for CY 1977-1979

Duty Station Assignment	On-Duty Rate <sup>b</sup>	Relative Risk	Sign. Mu	Off-Duty Rate <sup>b</sup>	Relative Risk	Sign. Mu
Total Navy <sup>a</sup>	33	1.00	--	107	1.00	--
UDT/Seal	62	1.88	N.S.	113	1.06	N.S.
Carrier	52	1.58 <sup>c</sup>	p<.01	108	1.01	N.S.
Cruiser	37	1.12	N.S.	131	1.22 <sup>c</sup>	p<.05
Amphibious	38	1.15	N.S.	116	1.08	N.S.
Rescue/Salvage	46	1.39	N.S.	120	1.12	N.S.
Nuclear Carrier	43	1.30	N.S.	99	0.92	N.S.
Destroyer	40	1.21 <sup>c</sup>	p<.05	118	1.10 <sup>c</sup>	p<.05
Submarine	9	0.24	N.S.	116	1.08	N.S.
Repair	30	0.91	N.S.	117	1.09	N.S.
Replenishment	45	1.36 <sup>c</sup>	p<.05	100	0.93	N.S.
Patrol/Mine	57	1.73	N.S.	100	0.94	N.S.
Attack/Fighter Squadron	34	1.03	N.S.	100	0.94	N.S.
Patrol Squadron	27	0.82	N.S.	105	0.99	N.S.
Helicopter Squadron	26	0.79	N.S.	102	0.96	N.S.
Construction Battalion	28	0.85	N.S.	111	1.05	N.S.
Nuclear Cruiser	22	0.67	N.S.	97	0.92	N.S.
Fleet Marine Force	33	1.00	N.S.	71	0.66 <sup>d</sup>	p<.05
Nuclear Submarine	22	0.67 <sup>d</sup>	p<.01	90	0.84 <sup>d</sup>	p<.05
All Other (Shore)	28	0.85 <sup>d</sup>	p<.01	105	0.98	N.S.

<sup>a</sup>All male enlisted personnel

<sup>b</sup>Rates are per 10,000

<sup>c</sup>Significantly higher than Navy norm

<sup>d</sup>Significantly lower than Navy norm

Comparing the highest and lowest relative risks from Table 1, UDT/Seal (demolition) personnel had 2.24 times the risk of injury hospitalization compared to Nuclear submariners.

#### Duty Status

Comparisons of age-adjusted injury hospitalization rates and relative risks by duty status (on-duty or off-duty) are shown in Table 2 for each duty station.

Personnel on Destroyers, Replenishment ships and non-nuclear Carriers had on-duty hospitalization rates that were significantly higher than the Navywide rate. Carrier personnel experienced a rate that was 36.5% higher than the Navy norm for on-duty accident hospitalizations. Nuclear submariners and shore-based personnel had on-duty rates that were significantly lower than experienced Navywide. Carrier personnel had 2.36 times the risk of on-duty injury hospitalization compared to Nuclear submariners.

For off-duty injuries, non-nuclear Cruiser personnel had a hospitalization rate that was 18.3% higher than that observed for the entire Navy. This rate was nearly twice that of Fleet Marine Force personnel who had an off-duty injury hospitalization rate 51.0% lower than the Navy norm.

Destroyer was the only type of duty station whose personnel had significantly higher rates for both on- and off-duty injury hospitalizations compared to the total Navy. Similarly, Nuclear Submarine personnel had significantly lower on- and off-duty rates compared to the Navy norm.

The rank order correlation between on- and off-duty injury hospitalization was significant ( $\rho = 0.49$ ,  $p = .05$ ). Personnel who had high on-duty hospitalization rates also experienced high rates off-duty.

#### DISCUSSION

Our results indicate that risk of injury varies widely among Naval personnel as a function of duty station and duty status. Comparisons of the shore-based category "All Other" with the sea-based duty stations revealed that duty aboard Destroyers, Replenishment ships, or conventionally powered aircraft Carriers significantly increased an individual's risk of accident and injury.

Our data support the theory set forth by Gunderson [1976] that certain environmental variables common to shipboard living (noise, confined environment, long or irregular work hours with sleep deprivation, and lack of privacy) could be factors in the observed higher injury hospitalization rates. Hazards such as heavy machinery, propulsion plants and machine tools, usually associated with excessive noise and heat, may also play a fundamental role in injury occurrence [Ferguson et al, 1984]. These hazards, common to some degree, on most ships, suggest that shipboard work environments, particularly non-nuclear, exert a pervasive influence upon risk of injury.

While duty status clearly influences accident risk, the positive correlation between on- and off-duty injury hospitalization rates suggest that personal attributes may be operating in both settings. One of these attributes might be risk-taking attitudes. This hypothesis was also proposed in the Ferguson et al, study [1981b] which found a similar relationship between on- and off-duty accidents.



Unequal pay grade (seniority) or occupational distributions across the various duty stations may have been potential sources of bias. Since age and pay grade are highly correlated ( $r = 0.73$ ,  $p < .001$ ), age-adjustment also removed any confounding bias that may have been caused by uneven pay grade distribution.

The distribution of occupations by ship-type was calculated to determine if high-risk occupational groups, previously identified by Ferguson et al, [1981a] and Gunderson and Colcord, [1982], were concentrated on certain ships. With the exception of Replenishment ships, duty stations which were found to have higher injury hospitalization rates had occupational distributions similar to the total Navy.

Replenishment ships had a greater percentage of men in two high-risk occupational groups (Marine Engineers and Seamanship). Since these two groups made up nearly 50% of the crews, the higher on-duty rates observed for Replenishment ship personnel may merely be a reflection of this occupational distribution. The elevated rates may also be a reflection of the increased opportunity for accidents that may result from the high tempo of operations common to Replenishment ships (e.g. at-sea transfer of fuel, supplies, ammunition, and equipment).

It is interesting to note that only one sea-based duty station, Nuclear Submarine, had significantly lower on-duty hospitalization rates than the total Navy. A possible explanation is a corollary to the "healthy worker" effect, where one may hypothesize that stringent screening criteria allowed selection (for duty aboard this type of vessel) of better educated personnel who then exercised stricter safety vigilance. Duty on nuclear powered ships, in general, may encourage an increased sense of safety awareness and thus help to minimize risk of accident and injury.

#### CONCLUSIONS

This study has shown that duty status and type of duty station influence the risk of hospitalization due to injury. As others have pointed out, general environmental and occupational factors, as well as individual characteristics must be considered to determine if they exacerbate or reduce this risk.

Analyses of some additional variables could contribute to a better understanding of accidents. Specifically, are there interactions among factors such as type of accident (external cause), seniority (pay grade) and temporal factors (time in assignment) that would help explain the large observed differences in accident risk?

Finally, while this study has shown that there are differences in risk of injury between conventionally and nuclear-powered ships, further analyses are needed to determine if there are specific factors that explain these differences. Such detailed investigations will help identify high-risk assignments where preventive and corrective efforts should be focused. These points will be addressed in a continuing series of technical reports on accidental injury hospitalizations.

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looking at the effects of duty status on injury hospitalization, personnel from Destroyers, Replenishment ships, and conventionally powered Carriers had higher on-duty hospitalization rates, while Nuclear submariners and All Other personnel had lower on-duty rates compared to Navywide norms. For off-duty accidents, personnel on Cruisers and Destroyers had significantly higher rates, whereas Fleet Marine Forces and Nuclear submariners had significantly lower rates than were experienced in the total Navy. The positive and significant correlation observed between on- and off-duty hospitalization rates suggests that common personal attributes such as risk-taking behavior are manifested both on and off the job. Our results have shown that factors associated with the shipboard environment in general, and by ship type specifically, may contribute to the observed high risk of injury.

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